

CLAIMS

What is claimed is:

1       1. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4       a laser station that can weld the photonic package  
5 components; and,

6       an automated handling assembly that can load and unload  
7 the photonic package components in said laser station.

1       2. The machine of claim 1, wherein the photonic  
2 package components include a package and a fiber sleeve  
3 that are located in a horizontal position, said laser  
4 station includes three lasers that weld the fiber sleeve to  
5 the package.

1       3. The machine of claim 2, wherein said laser station  
2 includes a package tooling that holds the package, said

3 package tooling having a yoke that can rotate about two  
4 orthogonal axis.

1       4. The machine of claim 3, wherein said package tooling  
2 includes an actuator to assert a biasing force to said  
3 yoke.

1       5. The machine of claim 3, wherein said package  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1       6. The machine of claim 3, wherein said package  
2 tooling includes a friction band that can lock a position  
3 of said yoke.

1       7. The machine of claim 6, wherein said package  
2 tooling includes a vacuum channel that pulls said friction  
3 band into said yoke.

1       8. The machine of claim 6, wherein said package  
2 tooling has a vacuum channel that pulls said friction band  
3 away from said yoke.

1       9. The machine of claim 3, wherein said package  
2       tooling has a plurality of first electrical contacts that  
3       can be coupled to the package, and an actuator that moves  
4       said electrical contacts.

1       10. The machine of claim 9, wherein said package  
2       tooling includes a plurality of second contacts that can be  
3       coupled to said first contacts, and an actuator to move  
4       said second contacts relative to said yoke.

1       11. The machine of claim 6, wherein said package  
2       tooling includes a pair of rotary coupling that are pulled  
3       into said yoke with a vacuum pressure.

1       12. The machine of claim 3, wherein said laser station  
2       includes a fiber tooling that holds the fiber sleeve.

1       13. The machine of claim 12, wherein said fiber  
2       tooling includes an actuator to move the fiber sleeve into  
3       the package.

1       14. The machine of claim 13, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1       15. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4       station means for laser welding the photonic package  
5 components; and,

6       handling means for loading and unloading the photonic  
7 package components in the station means.

1       16. The machine of claim 15, wherein the photonic  
2 package components include a package and a fiber sleeve  
3 that are located in a horizontal position, said station  
4 means includes three lasers that weld the fiber sleeve to  
5 the package.

1       17. The machine of claim 16, wherein said station  
2 means includes a package tooling that holds the package,

3 said package tooling having a yoke that can rotate about  
4 two orthogonal axis.

1 18. The machine of claim 17, wherein said package  
2 tooling includes an actuator to assert a biasing force to  
3 said yoke.

1 19. The machine of claim 17, wherein said package  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1 20. The machine of claim 17, wherein said package  
2 tooling includes a friction band that can lock a position  
3 of said yoke.

1 21. The machine of claim 20, wherein said package  
2 tooling includes a vacuum channel that pulls said friction  
3 band into said yoke.

1 22. The machine of claim 20, wherein said package  
2 tooling has a vacuum channel that pulls said friction band  
3 away from said yoke.

1       23. The machine of claim 17, wherein said package  
2       tooling has a plurality of first electrical contacts that  
3       can be coupled to the package, and an actuator that moves  
4       said electrical contacts.

1       24. The machine of claim 23, wherein said package  
2       tooling includes a plurality of second contacts that can be  
3       coupled to said first contacts, and an actuator to move  
4       said second contacts relative to said yoke.

1       25. The machine of claim 17, wherein said package  
2       tooling includes a pair of rotary couplings that are pulled  
3       into said yoke with a vacuum pressure.

1       26. The machine of claim 17, wherein said laser  
2       station includes a fiber tooling that holds the fiber  
3       sleeve.

1       27. The machine of claim 26, wherein said fiber  
2       tooling includes an actuator to move the fiber sleeve into  
3       the package.

1        28. The machine of claim 27, wherein said actuator can  
2        vary a force applied by the fiber sleeve to the package.

1        29. An automated laser weld machine that welds  
2        together at least two photonic package components,  
3        comprising:

4        4        a first fixture that can hold first photonic package  
5        component in a horizontal position;

6        6        a second fixture that can hold a second photonic  
7        package component in a horizontal position adjacent to the  
8        first photonic package component;

9        9        a first laser that can emit a light beam to weld the  
10        first and second photonic package components;

11        11        a second laser that can emit a light beam to weld the  
12        first and second photonic package components; and,

13        13        a third laser that can emit a light beam to weld the  
14        first and second photonic package components.

1       30. The machine of claim 29, wherein the first  
2 photonic package component is a package and the second  
3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1       31. The machine of claim 30, wherein said first  
2 fixture has a yoke that can rotate about two orthogonal  
3 axis.

1       32. The machine of claim 31, wherein said first fixture  
2 includes an actuator to assert a biasing force to said  
3 yoke.

1       33. The machine of claim 31, wherein said first  
2 fixture includes a vibrator to apply vibratory energy to  
3 said yoke.

1       34. The machine of claim 31, wherein said first  
2 fixture includes a friction band that can lock a position  
3 of said yoke.

1       35. The machine of claim 34, wherein said first  
2 fixture includes a vacuum channel that pulls said friction  
3 band into said yoke.

1       36. The machine of claim 35, wherein said first  
2 fixture has a vacuum channel that pulls said friction band  
3 away from said yoke.

1       37. The machine of claim 31, wherein said first  
2 fixture has a plurality of first electrical contacts that  
3 can be coupled to the package, and an actuator that moves  
4 said electrical contacts.

1       38. The machine of claim 37, wherein said first  
2 fixture includes a plurality of second contacts that can be  
3 coupled to said first contacts, and an actuator to move  
4 said second contacts relative to said yoke.

1       39. The machine of claim 34, wherein said first  
2 fixture includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

1       40. The machine of claim 31, wherein said second  
2 fixture includes an actuator to move the fiber sleeve into  
3 the package.

1       41. The machine of claim 40, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1       42. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4       first fixture means for holding a first photonic  
5 package component in a horizontal position;

6       second fixture means for holding a second photonic  
7 package component in a horizontal position adjacent to the  
8 first photonic package component;

9       first welding means for welding the first and second  
10 photonic package components;

11           second welding means for welding the first and second  
12   photonic package components; and,

13           third welding means for welding the first and second  
14   photonic package components.

1           43. The machine of claim 42, wherein the first  
2   photonic package component is a package and the second  
3   photonic package component includes a fiber sleeve attached  
4   to a fiber.

1           44. The machine of claim 43, wherein said first  
2   fixture means includes a yoke that can rotate about two  
3   orthogonal axis.

1           45. The machine of claim 44, wherein said first fixture  
2   means includes an actuator to assert a biasing force to  
3   said yoke.

1           46. The machine of claim 44, wherein said first  
2   fixture means includes a vibrator to apply vibratory energy  
3   to said yoke.

1       47. The machine of claim 44, wherein said first  
2 fixture means includes a friction band that can lock a  
3 position of said yoke.

1       48. The machine of claim 47, wherein said first  
2 fixture means includes a vacuum channel that pulls said  
3 friction band into said yoke.

1       49. The machine of claim 47, wherein said first  
2 fixture means includes a vacuum channel that pulls said  
3 friction band away from said yoke.

1       50. The machine of claim 44, wherein said first  
2 fixture means includes a plurality of first electrical  
3 contacts that can be coupled to the package, and an  
4 actuator that moves said electrical contacts.

1       51. The machine of claim 50, wherein said first  
2 fixture means includes a plurality of second contacts that  
3 can be coupled to said first contacts, and an actuator to  
4 move said second contacts relative to said yoke.

1       52. The machine of claim 44, wherein said first  
2 fixture means includes a pair of rotary couplings that are  
3 pulled into said yoke with a vacuum pressure.

1       53. The machine of claim 44, wherein said second  
2 fixture means includes an actuator to move the fiber sleeve  
3 into the package.

1       54. The machine of claim 53, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1       55. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4       a first tooling that can hold a first photonic package  
5 component in a horizontal position, said first tooling  
6 having a yoke that can rotate about two orthogonal axis and  
7 an actuator that applies a biasing force to said yoke;

8       a second tooling that can hold a second photonic  
9    package component in a horizontal position adjacent to the  
10   first photonic package component; and,

11       a laser that can emit a light beam to weld the first  
12    and second photonic package components.

1       56. The machine of claim 55, wherein the first  
2    photonic package component is a package and the second  
3    photonic package component includes a fiber sleeve attached  
4    to a fiber.

1       57. The machine of claim 55, wherein said first  
2    tooling includes a vibrator to apply vibratory energy to  
3    said yoke.

1       58. The machine of claim 55, wherein said first  
2    tooling includes a friction band that can lock a position  
3    of said yoke.

1       59. The machine of claim 58, wherein said first  
2 tooling includes a vacuum channel that pulls said friction  
3 band into said yoke.

1       60. The machine of claim 58, wherein said first  
2 tooling has a vacuum channel that pulls said friction band  
3 away from said yoke.

1       61. The machine of claim 56, wherein said first  
2 tooling has a plurality of first electrical contacts that  
3 can be coupled to the package, and an actuator that moves  
4 said electrical contacts.

1       62. The machine of claim 61, wherein said first  
2 fixture includes a plurality of second contacts that can be  
3 coupled to said first contacts, and an actuator to move  
4 said second contacts relative to said yoke.

1       63. The machine of claim 55, wherein said first  
2 tooling includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

1        64. The machine of claim 56, wherein said second  
2 tooling includes an actuator to move the fiber sleeve into  
3 the package.

1        65. The machine of claim 64, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1        66. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4        a first tooling that can hold a first photonic package  
5 component in a horizontal position, said first tooling  
6 having a yoke that can rotate about two orthogonal axis and  
7 biasing means for applying a biasing force to said yoke;

8        a second tooling that can hold a second photonic  
9 package component in a horizontal position adjacent to the  
10 first photonic package component; and,

11        a laser that can emit a light beam to weld the first  
12 and second photonic package components.

1       67. The machine of claim 66, wherein the first  
2 photonic package component is a package and the second  
3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1       68. The machine of claim 66, wherein said first  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1       69. The machine of claim 66, wherein said first  
2 tooling includes a friction band that can lock a position  
3 of said yoke.

1       70. The machine of claim 69, wherein said first  
2 tooling includes a vacuum channel that pulls said friction  
3 band into said yoke.

1       71. The machine of claim 69, wherein said first  
2 tooling has a vacuum channel that pulls said friction band  
3 away from said yoke.

1       72. The machine of claim 67, wherein said first  
2 tooling has a plurality of first electrical contacts that  
3 can be coupled to the package, and an actuator that moves  
4 said electrical contacts.

1       73. The machine of claim 72, wherein said first  
2 tooling includes a plurality of second contacts that can be  
3 coupled to said first contacts, and an actuator to move  
4 said second contacts relative to said yoke.

1       74. The machine of claim 66, wherein said first  
2 tooling includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

1       75. The machine of claim 67, wherein said second  
2 tooling includes an actuator to move the fiber sleeve into  
3 the package.

1       76. The machine of claim 75, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1        77. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4        a first tooling that can hold a first photonic package  
5 component in a horizontal position, said first tooling  
6 having a yoke that can rotate about two orthogonal axis and  
7 a friction band that can lock and unlock said yoke;

8        a second tooling that can hold a second photonic  
9 package component in a horizontal position adjacent to the  
10 first photonic package component; and,

11        a laser that can emit a light beam to weld the first  
12 and second photonic package components.

1        78. The machine of claim 77, wherein the first  
2 photonic package component is a package and the second  
3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1        79. The machine of claim 77, wherein said first  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1        80. The machine of claim 77, wherein said first  
2 tooling includes a vacuum channel that pulls said friction  
3 band into said yoke.

1        81. The machine of claim 77, wherein said first  
2 tooling has a vacuum channel that pulls said friction band  
3 away from said yoke.

1        82. The machine of claim 78, wherein said first  
2 tooling has a plurality of first electrical contacts that  
3 can be coupled to the package, and an actuator that moves  
4 said electrical contacts.

1        83. The machine of claim 82, wherein said first  
2 tooling includes a plurality of second contacts that can be  
3 coupled to said first contacts, and an actuator to move  
4 said second contacts relative to said yoke.

1        84. The machine of claim 77, wherein said first  
2 tooling includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

1        85. The machine of claim 78, wherein said second  
2 tooling includes an actuator to move the fiber sleeve into  
3 the package.

1        86. The machine of claim 85, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1        87. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4        a first tooling that can hold a first photonic package  
5 component in a horizontal position, said first tooling  
6 having a yoke that can rotate about two orthogonal axis and  
7 lock means for locking and unlocking said yoke;

8       a second tooling that can hold a second photonic  
9    package component in a horizontal position adjacent to the  
10   first photonic package component; and,

11       a laser that can emit a light beam to weld the first  
12    and second photonic package components.

1       88. The machine of claim 87, wherein the first  
2    photonic package component is a package and the second  
3    photonic package component includes a fiber sleeve attached  
4    to a fiber.

1       89. The machine of claim 87, wherein said first  
2    tooling includes a vibrator to apply vibratory energy to  
3    said yoke.

1       90. The machine of claim 87, wherein said lock means  
2    includes a friction band that is pulled into said yoke.

1       91. The machine of claim 90, wherein said lock means  
2    includes a vacuum channel that pulls said friction band  
3    away from said yoke.

1       92. The machine of claim 88, wherein said first  
2 tooling has a plurality of first electrical contacts that  
3 can be coupled to the package, and an actuator that moves  
4 said electrical contacts.

1       93. The machine of claim 92, wherein said first  
2 tooling includes a plurality of second contacts that can be  
3 coupled to said first contacts, and an actuator to move  
4 said second contacts relative to said yoke.

1       94. The machine of claim 87, wherein said first  
2 tooling includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

1       95. The machine of claim 87, wherein said second  
2 tooling includes an actuator to move the fiber sleeve into  
3 the package.

1       96. The machine of claim 95, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1        97. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4        a first tooling that can hold a first photonic package  
5 component in a horizontal position, said first tooling  
6 having a yoke that can rotate about two orthogonal axis, a  
7 first plurality of contacts that can engage the package, a  
8 second plurality of contacts, and an actuator that can move  
9 said second plurality of contacts into said yoke so that  
10 said second plurality of contacts are electrically coupled  
11 to said first plurality of contacts;

12        a second tooling that can hold a second photonic  
13 package component in a horizontal position adjacent to the  
14 first photonic package component; and,

15        a laser that can emit a light beam to weld the first  
16 and second photonic package components.

1        98. The machine of claim 97, wherein the first  
2        photonic package component is a package and the second  
3        photonic package component includes a fiber sleeve attached  
4        to a fiber.

1        99. The machine of claim 97, wherein said first  
2        tooling includes a vibrator to apply vibratory energy to  
3        said yoke.

1        100. The machine of claim 97, wherein said first  
2        tooling includes a pair of rotary couplings that are pulled  
3        into said yoke with a vacuum pressure.

1        101. The machine of claim 98, wherein said second  
2        tooling includes an actuator to move the fiber into the  
3        package.

1        102. The machine of claim 101, wherein said actuator  
2        can vary a force applied by the fiber sleeve to the  
3        package.

1       103. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4       a first tooling that can hold a first photonic package  
5 component, said first tooling having a yoke that can rotate  
6 about two orthogonal axis, a first plurality of contacts  
7 that can engage the package, and actuator means for  
8 coupling a second plurality of contacts to said first  
9 plurality of contacts;

10       a second tooling that can hold a second photonic  
11 package component adjacent to the first photonic package  
12 component; and

13       a laser that can emit a light beam to weld the first  
14 and second photonic package components.

1       104. The machine of claim 103, wherein the first  
2 photonic package component is a package and the second

3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1 105. The machine of claim 103, wherein said first  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1 106. The machine of claim 103, wherein said first  
2 tooling includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

1 107. The machine of claim 104, wherein said second

2 tooling includes an actuator to move the fiber sleeve into  
3 the package.

1 108. The machine of claim 107, wherein said actuator  
2 can vary a force applied by the fiber sleeve to the  
3 package.

1 109. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4       a first tooling that can hold a first photonic package  
5   component, said first tooling having a yoke that can rotate  
6   about a plurality of bearings, a friction band that locks a  
7   position of said yoke with a vacuum pressure that also  
8   moves and seals said bearings;

9       a second tooling that can hold a second photonic  
10 package component adjacent to the first photonic component;  
11 and,

12       a laser that can emit a light beam to weld the first  
13 and second photonic package components.

1       110. The machine of claim 109, wherein the first  
2 photonic package component is a package and the second  
3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1       111. The machine of claim 109, wherein said first  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1        112. The machine of claim 110, wherein said second  
2        tooling includes an actuator to move the fiber sleeve into  
3        the package.

1        113. The machine of claim 112, wherein said actuator  
2        can vary a force applied by the fiber sleeve to the  
3        package.

1        114. A method for welding a first photonic package  
2        component to a second photonic package component,  
3        comprising:

4        loading a first photonic package component onto a first  
5        tooling with a robotic arm;

6        loading a second photonic package component onto a  
7        second tooling with the robotic arm; and,

8        welding the second photonic package component to the  
9        first photonic package component.

1 115. The method of claim 114, wherein the first and  
2 second photonic package components are welded in a  
3 horizontal position.

1 116. The method of claim 115, wherein the first and  
2 second photonic package components are welded with three  
3 lasers.